AMEIR SHAA

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EDUCATION

UNIVERSITY OF ALBERTA Edmonton, Canada
Doctor of Philosophy (PhD): Physics May 2020 - May 2023

- **CGPA:** 3.95/4.00
- **Awards & Achievements:** Alberta Graduate Excellence Scholar (AGES)

UNIVERSITY OF ALBERTA Edmonton, Canada
Master of Science (MSc): Physics Jan 2019 - April 2020

- **CGPA:** 3.93/4.00

NANYANG TECHNOLOGICAL UNIVERSITY (NTU) Singapore
Bachelor of Science (Hons): Major in Physics with Second Major in Mathematics Aug 2014 - Dec 2017

- **CGPA:** 4.88/5.00 (First Class Honors)
- **Awards & Achievements:** Nanyang Scholar, CN Yang Scholar
- **Competitions:** Most Promising Young Scientist, The Scientist (Gold/ Overall Winner)

WORK EXPERIENCE

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH (CERN) Geneva, Switzerland
Collaborator of the Monopole and Exotics Detector at the LHC (MoEDAL) May 2016 - Present

- **Computing**
  - Implemented Convolutional Neural Networks (CNNs) and Support Vector Machines (SVMs) (machine learning techniques) in order to study and characterize the types of particles passing through the MoEDAL sub-detector - the Nuclear Track Detectors - in order to efficiently search for avatars of new physics. (2017)
  - Characterized the data collected from the Timepix detector to better understand the types of elementary particles passing through the MoEDAL cavern. Implemented machine learning techniques (Random Forests) to automate the characterization of the data to better faciliate the discovery of new particles. (2016)
  - Revamped the MoEDAL framework for GEANT4 - GAUSS - which simulates particles passing through the MoEDAL cavern and processes their energy loss in order to emulate the real-life events of proton-proton collisions at the Large Hadron Collider (LHC). (2016)
  - Revamped the MoEDAL framework for DIRAC which uses distributed High Performance Computing (HPC) based in the UK for simulations in order to use their services more efficiently. (2016)

- **Experimental**
  - Led a campaign of scanning the MoEDAL sub-detector - the Magnetic Monopole Trapper - for traces of new physics and magnetic charge using a Superconducting Quantum Interference Device (SQUID) at ETH Zurich Lab for Paleomagnetism. (2016, 2017, 2018, 2019)
  - Involved in the design, building and installation of a new detector, MAPP (MoEDAL Apparatus for Penetrating Particles) , for mini-ionising avatars of new physics as well as long lived neutral particles. (2020, 2021, 2022)

- **Theoretical**
    - Derived the expression for the classical and quantum scattering of an electric dipole. (2022)
    - Derived the semi-classical and quantum expression of the energy loss of an electric dipole. (2022)
    - Derived predictions about the Weinberg angle from various monopole models and compared how close the predictions are to the actual value of the Weinberg angle. (2021)
    - Derived the Lagrangian for the Spin One monopole and created the Monte Carlo model for the Spin One monopole using FeynRules in Madgraph. (2017)
    - Revamped the existing Spin Zero and Spin Half monopole models in Madgraph by deriving the Lagrangian for the Spin Zero and Spin Half monopole and re-creating the Monte Carlo model for the Spin Zero and Spin Half monopole using FeynRules in Madgraph. (2017)

- **Others**
    - Supervised summer students at CERN for various MoEDAL-related projects while teaching the basics of particle physics as well as Monte-Carlo simulation technqiues (Madgraph5, Pythia8, SuperChic, etc) and/or GEANT4 simulation techniques. (2018, 2019, 2020)

- **Phenemenology**
    - Led a search for highly ionizing particles (monopoles and highly electrical charged objects) produced by the Drell-Yan (DY with photon and Z boson exchange) and photon fusion mechanisms using the data collected by the MoEDAL experiment during Run 2 of the LHC with proton-proton centre of mass energies of 13 TeV and a luminosity of 6.46 inverse femtobarns utilizing the MoEDAL sub-detectors - the Magnetic Monopole Trappers (MMTs) and the Nuclear Track Detectors (NTDs). (2022)
    - Led a search for highly ionizing particles (monopoles and highly electrical charged objects) produced by the Drell-Yan (DY with photon and Z boson exchange) mechanism using the data collected by the MoEDAL experiment during Run 1 of the LHC with proton-proton centre of mass energies of 8 TeV and a luminosity of 2.2 inverse femtobarns utilizing the MoEDAL sub-detectors - the Magnetic Monopole Trappers (MMTs) and the Nuclear Track Detectors (NTDs). (2021)
    - Led a search for dyons (particles with a magnetic and electric charge) produced by the Drell-Yan (DY with photon exchange) mechanism using the data collected by the MoEDAL experiment during Run 2 of the LHC with proton-proton centre of mass energies of 13 TeV and a luminosity of 6.46 inverse femtobarns utilizing the MoEDAL sub-detector - the Magnetic Monopole Trappers (MMT). (2020)
    - Led a search for Long Lived Charged Particles produced by decays using the simulated data collected by the MAPP (MoEDAL Apparatus for Penetrating Particles) experiment during Run 3 of the LHC with proton-proton centre of mass energies of 14 TeV and a luminosity of 30 inverse femtobarns utilizing the MAPP detector. (2020)
    - Led an analysis for MoEDAL during the proton-proton and electron-electron phase of the FCC with completely reimagined sub-detectors in order to determine the types of new physics MoEDAL could be sensitive to in the future as well as placing hypothetical limits at FCC energies on particles (monopoles, HECOs, dyons, etc) MoEDAL is currently sensitive to. (2020)
    - Led an analysis for MAPP during the proton-proton and electron-electron phase of the FCC with completely reimagined sub-detectors in order to determine the types of new physics MAPP could be sensitive to in the future as well as placing hypothetical limits at FCC energies on particles (milli-charged particles, long-lived neutrals, heavy neutrinos, long-lived charged particles, etc) MAPP is currently sensitive to. (2020)
    - Led an analysis for MAPP by parameterizing simulated data to obtain a mathematical model for the sensitivity of MAPP to long-lived neutral particles during different proton-proton centre of

mass energies of the LHC as well as the FCC. (2020)

- Led a search for monopoles produced by the Drell-Yan (DY with photon exchange) mechanism using the data collected by the Compact Muon Solenoid (CMS) experiment during Run 1 of the LHC with proton-proton centre of mass energies of 8 TeV and a luminosity of 180 inverse nanobarns utilizing the CMS beampipe. (2020)
- Led a search for Long Lived Neutral Particles produced by the decay of the bottom quark using the simulated data collected by the MAPP (MoEDAL Apparatus for Penetrating Particles) experiment during Run 3 of the LHC with proton-proton centre of mass energies of 14 TeV and a luminosity of 30 inverse femtobarns utilizing the MAPP detector. (2019)
- Led a search for monopoles produced by the Drell-Yan (DY with photon exchange) mechanism using the simulated data collected by the MoEDAL experiment during Run 3 of the LHC with proton-proton centre of mass energies of 14 TeV and a luminosity of 30 inverse femtobarns utilizing the MoEDAL sub-detector - the Magnetic Monopole Trappers (MMT). (2019)
- Led a search for monopoles produced by the Drell-Yan (DY with photon exchange) mechanism using the simulated data collected by the MoEDAL experiment during the proton-proton phase of the (Future Circular Collider) FCC with proton-proton centre of mass energies of 100 TeV and a luminosity of 3000 inverse femtobarns utilizing the MoEDAL sub-detector - the Magnetic Monopole Trappers (MMT). (2019)
- Led a search for Milli-Charged Particles produced by the Drell-Yan (DY with photon exchange) mechanism using the simulated data collected by the MAPP experiment during Run 3 of the LHC with proton-proton centre of mass energies of 14 TeV and a luminosity of 30 inverse femtobarns utilizing the MAPP. (2018)
- Led an analysis for the fiducial regions in the MoEDAL experiment during Run 2 of the LHC in order to determine the type of new physics that would be most sensitive to MoEDAL. This involved random particle gun simulations over a range of momenta and solid angles. (2018)
- Led a search for Heavy Neutrinos produced by the Drell-Yan (DY with photon exchange) mechanism using the simulated data collected by the MAPP (MoEDAL Apparatus for Penetrating Particles) experiment during Run 3 of the LHC with proton-proton centre of mass energies of 14 TeV and a luminosity of 30 inverse femtobarns utilizing the MAPP detector. (2018)
- Led a search for monopoles produced by the photon-fusion mechanism using the data collected by the MoEDAL experiment during Run 2 of the LHC with proton-proton centre of mass energies of 13 TeV and a luminosity of 0.371 inverse femtobarns utilizing the MoEDAL sub-detector - the Magnetic Monopole Trappers (MMT). (2017)
- Led a search for monopoles produced by the Drell-Yan (DY with photon exchange) mechanism using the data collected by the MoEDAL experiment during Run 2 of the LHC with proton-proton centre of mass energies of 13 TeV and a luminosity of 0.371 inverse femtobarns utilizing the MoEDAL sub-detector - the Magnetic Monopole Trappers (MMT). (2017)
- Led a search for monopoles produced by the Drell-Yan (DY with photon exchange) mechanism using the data collected by the MoEDAL experiment during Run 1 of the LHC with proton-proton centre of mass energies of 8 TeV and a luminosity of 0.75 inverse femtobarns utilizing the MoEDAL sub-detector - the Magnetic Monopole Trappers (MMT). (2016)

SKILLS

- **Language Skills**: Fluent/Native in English, Malay, Tamil ; Working knowledge of French, Swiss-German
- **Programming Skills**: Proficient in Python, Matlab, C++, ROOT
- **Computing / IT Skills**: Geant4, Git, Microsoft Office (Advanced), UNIX, LaTeX, Pythia, Madgraph, SuperChic

REFERENCES

- **Prof. James Pinfold (May 2016 - Present)**
    - **Relationship**: Collaborator, Spokesperson of MoEDAL experiment, Supervisor (Jan 2019 - May 2023)
    - **Contact**: Department of Physics, University of Alberta, Edmonton, AB Canada T6G 2R3; jpinfold@ualberta.ca; +1 (780) 492 2498
- **Prof. Albert de Roeck (May 2016 - Present)**
    - **Relationship:** Collaborator, Supervisor (May 2016 - Dec 2018)
    - **Contact:** Physics Department, CERN, CH-1217, Meyrin, Switzerland; albert.de.roeck@cern.ch; +41 22 7677384

SELECTED PUBLICATIONS

- **Minicharged Particles at Accelerators: Progress and Prospects**
    - A. Shaa et al, arXiv:2307.07855, 2023
- **Search for Highly-Ionizing Particles in pp Collisions at the LHC's Run-1 Using the Prototype MoEDAL Detector**
    - A. Shaa et al, The European Physical Journal C, Volume 82, 694, 2022
- **Search for Magnetic Monopoles Produced via the Schwinger Mechanism**
    - A. Shaa et al, Nature, 602, 2022
- **First Search for Dyons with the Full MoEDAL Trapping Detector in 13 TeV pp Collisions**
    - A. Shaa et al, Phys. Rev. Lett., 126 (071801), 2021
- **Prospects of Searches For Long-Lived Charged Particles with MoEDAL**
    - A. Shaa et al, The European Physical Journal C, Volume 80, 572, 2020
- **Searching for Heavy Neutrinos with the MoEDAL-MAPP Detector at the LHC**
    - A. Shaa et al, Physics Letters B, 802:135204, 2020
- **Magnetic Monopole Search with the Full MoEDAL Trapping Detector in 13TeV pp Collisions Interpreted in Photon-Fusion and Drell-Yan Production**
    - A. Shaa et al, Phys. Rev. Lett., 123 (021802), 2019
- **Search for Magnetic Monopoles with the MoEDAL Forward Trapping Detector in 2.11 fb^{-1} of 13 TeV Proton-Proton Collisions at the LHC**
    - A. Shaa et al, Physics Letters B, 782:510-516, 2018
- **Search for Magnetic Monopoles with the MoEDAL Forward Trapping Detector in 13 TeV Proton-Proton Collisions at the LHC**
    - A. Shaa et al, Phys. Rev. Lett., 118 (061801), 2017

SELECTED CONFERENCES

- **IAS-CERN Joint Workshop @ NTU**
  - **Singapore; 2016**
- **7th MoEDAL Collaboration Conference;**
  - **Bologna, Italy; 2017**
- **9th MoEDAL Collaboration Conference;**
  - **Vaasa, Finland; 2018**
- **Searching for Long-Lived Particles at the LHC;**
  - **CERN, Geneva; 2019**
- **11th MoEDAL Collaboration Conference;**
  - **Prague, Czech Republic; 2019**
- **LHCC Students' Poster Session 2020;**
  - **CERN, Geneva; 2020**
- **8th Edition of the Large Hadron Collider Physics Conference (LHCP);**
  - **Paris, France / Online; 2020**
- **18th MoEDAL Collaboration Conference**
  - **CERN, Geneva; 2022**
- **19th MoEDAL Collaboration Conference**
  - **CERN, Geneva; 2023**